REMARKS

Reconsideration of this application is respectfully requested in view of the foregoing amendment and the following remarks.

Claims 7, 11, and 13 are currently pending. By the foregoing Amendment, claims 7 and 11 have been amended without introducing new matter. Clear support for these amendments can be found at the specification at, for example, page 7, lines 8-14 and 23-25. Therefore, no new matter has been introduced.

In the final Office Action mailed October 17, 2007, the Examiner maintained her former position: claim 7 was rejected under 35 U.S.C. § 103(a) as being allegedly unpatentable over U.S. Patent No. 6,531,405 to Wegleiter ("Wegleiter") in view of U.S. Patent No. 4,914,667 to Blonder et al. ("Blonder") and claims 11 and 13 were rejected under 35 U.S. C. § 103(a) as being allegedly unpatentable over Wegleiter in view of Blonder, and further in view of JP57196580 to Nishiwaki et al. ("Nishiwaki"). To the extent that the rejections remain against the claims as pending, Applicants hereby traverse the rejections as follows.

Claim 7, as amended, recites a light emitting diode comprising a pellet, a major front surface of which, where an electrode is formed, is made of a GaAsP mixed crystal, characterized in that the major front surface is a rough surface; and characterized in that all side surfaces of the pellet are rough surfaces, wherein the rough surfaces are formed with fine projections with convex surfaces, the fine projections being arc-like sectional shapes to be formed densely by wet-etching the pellet, and wherein each of the fine projections has a diameter in a range of 0.3 μm to less than 3 μm, and wherein the

convex surfaces of the rough surfaces are configured to allow a light getting to an interface between a light emitting surface and the air at an angle larger than a critical angle of total reflection θ to be transited into the air through the convex surfaces.

Claim 11, as amended, recites a fabrication process for a light emitting diode having a pellet, a major front surface of which, where an electrode is formed, is made of a GaAsP mixed crystal, characterized in that the pellet is treated with an etching solution of an aqueous solution containing Br_2, nitric acid, hydrofluoric acid and acetic acid or I_2, nitric acid, hydrofluoric acid, and acetic acid to form fine projections that are arc-like sectional shapes to be formed densely on the major front surface and all side surfaces of the pellet, wherein the fine projections have a diameter in a range of 0.3 μm to less than 3 μm.

None of Wegleiter, Blonder, and Nishiwaki, when taken singly or in combination thereof, teaches or suggests all of the limitations of amended claims 7 or 11 as described above.

The Examiner admitted that Wegleiter does not explicitely teach the range of the diameter as claimed but consistently alleged that Blonder teaches an analogous device having a diameter or width of the projections (rib structure) 23 about 3 micrometers. Applicants respectfully disagree.

Blonder is not related to a light emitting diode, nor a wet etching process for roughing the surfaces of a pellet. Rather, Blonder describes an optical communications structure that comprises a Bragg reflector including substrate 21, cladding layer 22 and 24, and waveguide layer 23. The substrate 21 is attached to submount 20 that in turn is

attached to a submount 10. See Blonder, Fig. 1 and col. 3, lines 42-65. The waveguide layer 23 has rib structure and the width of the rib may be approximately 3 micrometers that is conveniently made by deposition of a 120-nanometer layer, followed by etching of a mesa in the presence of a photodefined mask covering the rib. See Blonder, col. 4, lines 20-24. The Applicants respectfully submit that such etching process is <u>not</u> a wet etching process and the rib structure is not a "fine projection" as recited in amended Claims 7 and 11. Due to different technology considerations, i.e., Blonder does not teach manufacturing a LED comprising a pellet, a major front surface of which, where an electrode is formed, is made of GaAsP, as recited in amended Claims 7 and 11, it would not have been obvious or one skilled in the art would not be motivated to combine Wegleiter and Blonder to achieve the LED of amended Claim 7.

Indeed, Blonder is intended to design a proper Bragg reflector to increase the stability of a laser (see Summary and the Abstract of Bragg.) However, the present invention is intended to improve a light extraction efficiency by making the surface rough (see Fig. 3 of the specification.) For example, the Abstract of Blonder describes that by suitable design of the Bragg reflector it is possible to render mode stability of negligible influence on error rate. Furthermore, from Fig. 1 and the detailed description, Blonder merely discloses "diffraction grating", which, during laser operation, serves as a Bragg-reflection element. The advantage of diffraction grating in Blonder is to make the wavelength regular (or constant) (See Fig. 14 of Blonder.) According to Blonder, it is difficult to make the surface roughed randomly as in the present invention.

On the other hand, in Blonder, the light extraction is in the horizontal direction, not from the surface on which the diffraction grating is formed, as shown in direction hv in Fig. 1 of Blonder. Even more, Blonder merely states that "the width of the rib may be approximately 3 micrometers" (see col. 4, lines 24-25). Please note that the dimension is for width of the rib, which namely means a pitch of the rib, not a "diameter" as claimed.

Moreover, the "3 micrometers" is the only dimension that is mentioned or discussed in Blonder. The Applicants respectfully submit that by employing the etching process of Blonder, it would be difficult to manufacture a rib structure with a dimension in the range of 0.3 μm to less than 3 μm, as recited in amended Claims 7 and 11. Accordingly, it is respectfully submitted that amended Claim 7 is allowable over Wegleiter in view of Blonder.

In rejecting Claim 11, the Examiner further relied on Nishiwaki and asserted that Nishiwaki teaches an etching solution containing Br_2, nitric acid, hydrofluoric acid and acetic acid, or I_2, nitric acid, hydrofluoric acid, and acetic acid. Applicants again respectfully disagree. The Applicants respectfully disagree because is it clear that from the English Abstract of Nishiwaki, the etching solution only contains Br_2, nitric acid, and water, not Br_2, nitric acid, hydrofluoric acid and acetic acid, or I_2, nitric acid, hydrofluoric acid, and acetic acid, as recited in amended Claim 11. To support this, Applicants attach a copy of machine-translated English specification of Nishiwaki for reference. In the machine-translated English specification, it clearly shows that the etching solution used in Nishiwaki only contains Br2, nitric acid, and water, not Br2, nitric acid, hydrofluoric acid and acetic acid or I2, nitric acid, hydrofluoric acid, and acetic acid, as recited in amended

Claim 11. Therefore, Applicants respectfully submit that the Examiner's allegation is completely improper.

With regard to Wegleiter, col. 2, line 30 of Wegleiter only describes "sawteeth" formed on the surface, which, however, is clearly not "arc-like shapes to be formed densely", as recited in amended Claims 7 and 11. Wegleiter also fails to teach or suggest convex surfaces of the rough surfaces are configured to allow a light getting to an interface between a light emitting surface and the air at an angle larger than a critical angle of total reflection θ to be transited into the air through the convex surfaces, as recited in amended Claim 7. The differences between Wegleiter and the present invention have been disclosed in the Declaration of Mr. Suzuki filed on April 24, 2007.

Accordingly, the Applicants respectfully submit that none of Wegleiter, Blonder, and Nishiwaki, when taken singly or in combination, teaches or suggests at least the combinations of the features that the rough surfaces of the pellet are formed with fine projections <u>with convex surfaces, the fine projections being arc-like sectional shapes to be formed densely</u> by <u>wet-etching</u> the pellet, and wherein each of the fine projections has a <u>diameter</u> in a range of 0.3 μm to <u>less than</u> 3 μm<u>, and wherein the convex surfaces of the rough surfaces are configured to allow a light getting to an interface between a light emitting surface and the air at an angle larger than a critical angle of total reflection θ to be transited into the air through the convex surfaces</u>, as recited in amended Claim 7.

Moreover, further based on the reasons with reference to amended Claim 7, it would not have been obvious for one skilled in the art to combine Wegleiter, Blonder, and

Nishiwaki to achieve the process of amended Claim 11. Accordingly, Claim 11, as amended, is allowable over the cited art.

As Claim 11 is allowable, the Applicants submit that Claim 13, which depends from Claim 11, is likewise allowable for at least the same reasons that Claim 11 is allowable, as well as for the additional subject matter recited therein.

Conclusion

Applicants respectfully submit that this application is in condition for allowance and such action is earnestly solicited. If the Examiner believes that anything further is desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact Applicants' undersigned representative at the telephone number listed below to schedule a personal or telephone interview to discuss any remaining issues.

In the event that this paper is not considered to be timely filed, an appropriate extension of time is requested. Any fees for such an extension, together with any

additional fees that may be due with respect to this paper, may be charged to counsel's Deposit Account Number 01-2300, referencing **Docket Number 107242-00005**.

Respectfully submitted,
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Enclosure: A copy of machine-translated English translation of Japanese Patent Publication No. 59085868 A to Nishiwaki et al, published July 17, 1984

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Equation 1 of the invention

Request for examination not requested

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(14)

Etchant

⑳

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⑳

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Specification

1. TITLE OF THE INVENTION

Etchant

2. WHAT IS CLAIMED IS:

(1)

Etchant including the thing comprising saturated bromine water, water to etch an InP system semiconductor material and the 98% nitric acid.

(2)

Etchant as claimed in the claims (1) clause that is 5 to 1 even if there are few one pair of mixture ratios of the 98% nitric acid vs. the water vs. the said saturated bromine water.

3. The DETAILED DESCRIPTION OF THE INVENTION present invention relates to etchant to etch an InP system semiconductor material.

An InP system semiconductor laser is regarded as rose color as wavelength λ =1.3μm that a loss of the light via the optical fiber inside becomes very small, a source of light of the neighborhood of 1.55μm, but the reason is because In1-XGaAsyP1 · y can choose a band gap in the range of λ =0.92-1.67μm by Ga and composition ratio x of the As, y freely.

Therefore semiconductor integrated optics forming a laser, a modulator, waveguide to thing re-Schick to an InP/InGaAsP element is the optical device which is importance.

When integrated optics is made on a board, at first establishment of the lithographic technique is the problem that must be achieved, but when InP/InGaAsP is etched, because, for example, it is HCl system, H2SO4-based, and there is not tolerance of the resist for the etching solution such as the aqua regia, a S1O2 film is formed on a board, a pattern is made in it, a double processing process that it wore a mask was necessary.

Minute processing is possible, and the present invention is going to provide resistant preferable etchant of the resist for the solution of problems in the technology such as the above.

In other words this invention is etchant including the thing comprising saturated bromine water, water and the 98% nitric acid as solution etching InP and InGaAsP, and it refers to the saturation water solution which bromine is put through here with the saturation bromine water underwater, and was saturated, there are bromine and next bromous acid in liquid.

The ratio that is suitable with this saturated bromine water and water and 98% nitric acid, it is preferably 1:00

At a minimum, because it is gentle, and the InP system semiconductor material can be dissolved to solution mixed comparatively of 5:1, it is effective to make unevenness of less than or equal to 1μm in depth.

Thus, it is most suitable for the processing of a diffraction grating or the optical waveguide of the submicron order that is indispensable to integrated optics.

Also, because tolerance of the resist is good, the processing process that films such as SiO2 are formed conventionally, and patterning does in this is omitted, and resist itself can be done with a mask.

It can adjust by modifying quantity of the water the solution used as etchant mixes saturated bromine water and the 98% nitric acid of the same amount, and the density does the capacity of saturation bromine water or the 98% nitric acid in a standard, and to add, but as around 5 times of the quantity of saturation bromine water or the 98% nitric acid are at least desirable for the quantity of practical use water supply addition, and quantity of the water increases than this from a point of the etching speed, etching speed falls.

In the following, use example of the etchant which further hangs to the present invention is described.

FIG. 1 is saturated bromine water to the Sn dope n-InP board:

H2O:

98%HNO3=1:5:

An experiment result in search of etching time of one solution and relations of the etching depth is shown.

The biting into in the etching interface becomes intense as indicated in FIG. 2 by the etching more than five minutes, but because linear shape characteristics are preferable like illustration by the experiment until around 5 minutes, and the surface state that was also etched is good, for example, microstructure in the integrated optics such as gratings can be produced in waveguide stripe, a submicron period of the distribution return laser use.

Also, it is recognized that it is etching speed at the same level as an InP board (for 560,?, /) by the result that etched an InGaAsP epitaxial board (wavelength λ =1.23μm corresponding to the band gap) by the same etchant.

Because, as for the etchant of the present invention, tolerance of the resist is good as if it was given in the above, it is not necessary to make patterning, and resist itself can be done with a mask to be able to form films such as SiO2, because the gratings in a submicron period tininess processing approximately 560 of InP/InGaAsP can be etched with the speed for /, on the occasion of the production such as a semiconductor product

using InP/InGaAsP namely integrated optics, a semiconductor laser, photodiode, the field effect transistor, extremely effective etchant will be provided.

4. BRIEF DESCRIPTION OF DRAWINGS FIG. 1 is a graph showing time for etching of the case using the etchant of the present invention and relations of the etching depth, and FIG. 2 is a sectional view showing a state when it was etched with this solution more than five minutes.

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FIG. 1

It is an etch depth

Time

FIG. 2

Resist

By the long time etching it encroachs